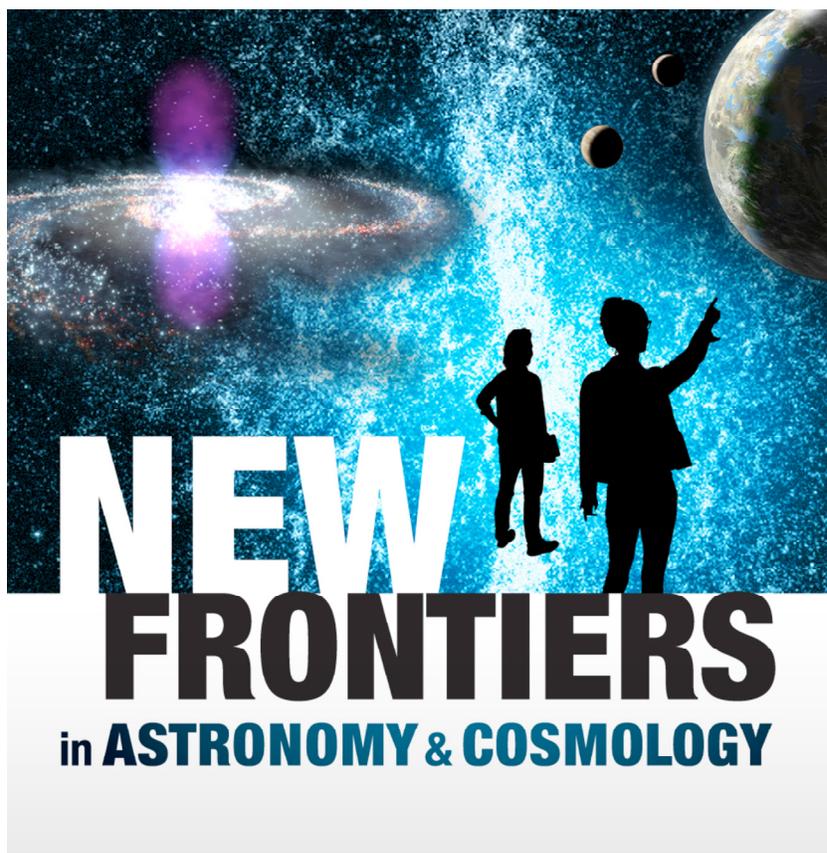


REQUEST FOR PROPOSALS



An International Grant Competition In Celebration of the Centenary of the Birth of Sir John Templeton

Projected Timeline for Key Program Activities

February 2012	Release of the formal Request for Proposals
April 16, 2012	Online pre-application form due
June 1, 2012	Deadline for submitting research proposals
September 2012	Recipients notified (all categories)
October 12-13, 2012	Awards ceremony, Philadelphia, PA, USA
June 2014	Project review meeting, Chicago, IL, USA
December 2014	Conclusion of program

OVERVIEW

The purpose of the *New Frontiers in Astronomy and Cosmology* Request for Proposals (RFP) program is to advance fundamental scientific understanding in areas of astronomy and cosmology that engage “Big Questions” by supporting imaginative scientific research. The program is particularly intended to support research that, because of its non-mainstream nature, or because of the breadth of the questions asked, would not be usually funded by conventional funding sources.

The program particularly focuses on supporting rigorous scientific research into the following Big Questions that naturally arise from science itself but have potential to expand the boundaries and deepen the foundation of scientific inquiry, thus paving the way for a more comprehensive understanding of the world.

- (I) What was the earliest state of the universe?
- (II) Is our universe unique or is it part of a much larger multiverse?
- (III) What is the origin of the complexity in the universe?
- (IV) Are we alone in the universe? Or, are there other life and intelligence beyond the solar system?

Exemplary sub-questions and elaboration of each Big Question may be found at the end of this RFP document.

In conjunction with the grants program, prizes for high school and college student essays are offered. The purpose of the essay program is to inspire students to consider careers in science and prepare to be the original Big Question thinkers of future scientific research. Please e-mail bigquestions@oddjob.uchicago.edu for details of the *New Cosmic Frontiers Essay Contest*.

The award/prize winners will be honored at an international gathering, scheduled for October 12-13, 2012, in Philadelphia, Pennsylvania, USA.

AWARDS OFFERED

The following awards are offered. About 15 awards are anticipated.

- Grants for theoretical work, up to \$300,000 for two years.
- Grants for experimental research, up to \$500,000 for two years.

☞ ELIGIBILITY

- This RFP is limited to research in astronomy, astrophysics, cosmology, and related fields. Both theoreticians and experimentalists are encouraged to apply.
- This RFP is limited to research with potentially significant and broad implications for our understanding of the nature of cosmic reality.
- This RFP is intended to fill the gap in conventional funding. The RFP is not for research that could be considered mainstream, for which substantial funding is already available from conventional funding sources. The program is intended to support research that, because of its imaginative, non-mainstream nature, or because of the breadth of the questions asked, would be unlikely to receive mainstream funding support at this time.
- The proposed research must be rigorous and creative in terms of ideas and the demonstrated research capabilities of the applicants.
- Although drawing on previous work and solid expertise, researchers must push themselves toward an area of inquiry that is clearly foundational.
- The offer of the Research Grant will be limited to research that has the potential to significantly impact basic and “big picture” understandings of the universe.
- Technical proposals are ideal. However, it is important that they are not “merely technical.” It should be clear how results engage the Big Questions posed in this Request for Proposals. It is the sole burden of the applicant to make a detailed case.
- Proposers must identify one of the four Big Questions about which they are applying and one of the exemplary sub-questions that are listed under these head questions or formulate their own research questions to be pursued within the given questions provided that such questions are *directly* or *significantly* relevant to the one of four Big Questions.
- There is no restriction on the nationality or the location of the institution of applicants. However, the submission must be made in English.
- Proposals must be submitted using the form and page limits to be found on the Program website www.NewFrontiersinAstronomy.org.

☞ CRITERIA OF MERIT

Each proposal will be evaluated according to the following criteria:

- *Potential* for significant contribution to our basic foundational understanding of nature, and the likelihood for opening new, fruitful lines of inquiry. Preference will be given to proposals that succeed in arguing that new areas of research may open up as a result of the research or, alternatively that the mainstream approach to Big Questions and dilemmas can be upset by the proposed research (up to 30 points);
- Intrinsic *intellectual merit*, *scientific rigor* and *originality* of the submitted proposal (up to 30 points);
- *Qualifications* of the applicants and proposals (up to 20 points);
- Persuasiveness of the *practicality* of the plan and of the applicant’s ability to use the grant to continue to advance the themes explored in the proposal submitted as the basis for the application (up to 20 points).

The Program is NOT likely to Support the Following Research:

- The RFP is NOT for research that could be considered mainstream, for which substantial funding is already available from conventional funding sources. The following are some examples of areas this program is NOT likely to support:
 - “Fundamental” research in mainstream string theories and/or established programs in quantum gravity.
 - Research on a novel candidate for dark matter.
 - Computer simulations of evolutions of galaxies.
 - Astrophysical determinations of dark energy properties.
 - However, a proposal, though drawing on ideas such as those noted, may be considered if it is made clear that the proposal (1) pushes the boundary of fundamental inquiry further and (2) is relevant to the program intent.

It is the sole responsibility of the proposer of programs such as these to show that they are outside the realm of what can be funded by conventional sources.

- The RFP is NOT for **incremental** research advances, such as “normal” research in astronomy, astrophysics or cosmology based on existing ideas.
 - However, a proposal, though drawing on previous work, may be considered if it is clear that it (1) pushes the boundary of the fundamental inquiry further and (2) is relevant to the program intent.

The proposals that are subject to the previously stated quantitative evaluation MUST pass the filtering process described above.

USE OF GRANTS

Acceptable use of grant funds includes the following:

- Student or postdoctoral salary and benefits for part of the academic year.
- Summer salary for academics.
- Support for specific projects during sabbaticals.
- Assistance in writing or publishing books.
- Modest allowance for justifiable equipment, computers, publication charges, and other supplies. Expenditure of over 20% of the project budget for equipment must be sufficiently justified.
- Modest travel allowance.
- Modest overhead, no more than 15%.

Presence of co-funding is encouraged, while it is not mandatory.

AWARD PROCESS

- Call for Proposals Announced: February 2012.
- Online pre-application forms are due April 16, 2012. This form will be used to judge the size of the response and to provide a basis for choosing an appropriate jury. Applicants are requested to complete this simple online form to provide information on the following: a) the Big Question (one of I – IV) and a sub-question the proposal will address; b) the specific topic of the investigation; c) the procedures to be used (e.g., theoretical, observational, computational, laboratory), along with applicant information, the potential project title, and the estimated project budget; and d) the names of three potential referees.
- Proposals are due June 1, 2012. Please make sure to use the specified form for full proposals, available on the www.NewFrontiersinAstronomy.org website. The proposal must include a four-page executive summary of the project. This four-page executive summary is a critical part of the review process to select a set of finalists, to then be reviewed by a jury of world experts on the chosen topics. Therefore, the executive summary must address the four criteria of merit listed above.
- Announcement of winning proposals: September 2012.
- Commencement possibility: October 1, 2012.
- Receipt of interim reports: April 2013 and October 2013.
- Each grant winner is expected to attend a program review meeting in Chicago, in June 2014, and the proposed project budget must include the travel cost of a project team representative to attend this meeting. As a result of the presentations, further additional funding may be available by separate application to the John Templeton Foundation.
- Final written report, based on the June 2014 meeting, is due August 1, 2014.
- Papers published after August 1, 2014 must be reported to the Program.
- All funding must be dispersed by the end of December 2014. No-cost extensions are not allowed.

SELECTION OF WINNERS

- The finalists will be selected based mainly upon the four-page executive summary.
- Finalists will be evaluated according to the criteria of merit above by an appointed jury panel unique to each of the Big Questions (I) – (IV) posed in this RFP, comprised of world experts on the topic.
- Final funding decision will be made by the Science Committee, which will include a chair from each of four jury panels and one or two additional external experts.

AWARD CEREMONY

- All award winners will be invited and flown to Philadelphia for a two-day program, October 12 and 13, 2012, to be held in conjunction with the 100th anniversary celebration of the birth of the Founder of the John Templeton Foundation, Sir John Templeton; the 40th anniversary of the first Templeton Prize award; and the 25th anniversary of the establishment of the Foundation, to be held beginning on the evening of October 13.
- The program will include presentations by research award winners of their award winning proposals; a banquet; a noted original thinker presenting a public event lecture related to Big Questions; and a panel of Templeton Prize winners and other original thinkers, discussing the future of the Big Questions posed in this RFP.
- Winners are invited to the opening banquet of the John Templeton Foundation anniversary celebrations, on Saturday, October 13, 2012.

THE HONORARY ADVISORS

The Honorary Advisory Board has been established, separately from the Science Committee and jury panels. The Honorary Advisors to this program are the following eight Templeton Prize laureates whose expertise and interests are closely related to the program themes, listed below with year of the prize awarded.

John D. Barrow, 2006	Professor of Mathematical Sciences, University of Cambridge;
Paul Davies, 1995	Professor of Physics, Arizona State University;
Freeman Dyson, 2000	Professor Emeritus of Particle Physics, Institute for Advanced Study;
George Ellis, 2004	Professor Emeritus of Applied Mathematics, University of Cape Town;
Michael Heller, 2008	Professor of Philosophy, Pontifical Academy of Sciences, Copernicus Center for Interdisciplinary Studies, Krakow, Poland;
John Polkinghorne, 2002	Fellow and former President of Queens' College, University of Cambridge;
Martin Rees, 2011	Astronomer Royal;
Charles Townes, 2005	Emeritus Professor of Physics, University of California, Berkeley.

Proposals should be completed using the online templates available on the www.NewFrontiersinAstronomy.org website.

Attention: Donald G. York, New Frontiers Principal Investigator, The University of Chicago
E-mail: bigquestions@oddjob.uchicago.edu

Questions and inquiries regarding this RFP may be e-mailed to: bigquestions@oddjob.uchicago.edu.
No telephone inquiries will be accepted by the program.

Big Question I

What was the earliest state of the universe?

Exemplary sub-questions:

- (1) *What are the scientific ways to test various theories of the earliest state of the universe (cosmic genesis)?*
- (2) *What kinds of state or “laws” might have “preceded” the existence of spacetime?*
- (3) *If space and time are not fundamental in the deepest scientific description of the universe, how did they emerge?*

Astronomers have a good grasp on how the currently observable universe has evolved since shortly after the Big Bang. But what came before it? Several scientific ideas/theories of cosmic genesis have been put forward in the last few decades.

All of the cosmic genesis models presuppose the existence of some “laws” of physics. Are these laws *a priori* with respect to the universe? Are space and time emergent from more primitive elements (such as pregeometry)? Could they be different in different theories of cosmic genesis? Are there some meta-regularities which all these systems of laws would have to satisfy?

While most of these theories might be considered strictly theoretical exercises, cosmologists are contemplating ways to test some of them in the low energy regime. Are there observational consequences that can be *in principle* tested? The question of cosmic genesis is as old as the history of human thoughts and has been reflected upon by many philosophers and scientists. It is truly an exciting time to ask the question in light of these recent significant scientific advances.

Big Question II

Is our observable universe unique or is it part of a much larger multiverse?¹

Exemplary sub-questions:

- (1) Can the ideas of multiverse be empirically tested? If so, how? If not, what is the scientific and epistemological status of those domains that cannot be observed?*
- (2) What are the distinguishing characteristics of multiverses that are based on different quantum cosmologies?*
- (3) Many multiverse models invoke the idea of infinity as part of their explanatory apparatus. Can the physical world be infinite?*

The idea of a multiverse is based on the concept of cosmic inflation which may be considered independently of the issue of cosmic genesis. Inflation has now become part of the Standard Big Bang Cosmological Model due to its exceptional explanatory power and very precise recent experimental confirmations of some of its predictions. Among the potential consequences of the inflationary theory is that, if certain conditions are met, new "bubble universes" can be generated. The consequences would be the multiverse(s) in which mostly non-interacting universes exist with potentially different physical conditions. A fuller understanding of the very earliest phases of the Big Bang may reveal whether the physical conditions for an eternal inflation were actually met.

An important question has been raised whether or not the multiverse theory can ever be empirically tested, as we are dealing with the existence of universes to which we do not seem to have any access. Is the idea of the multiverse merely metaphysical? Or, are there any creative ways to empirically test the physical consequences of some versions of such theories? What is the scientific and epistemological status of the theories about these seemingly unobservable objects? Will any of these issues be forever beyond the science?

¹ This RFP is closely related to the question for the RFP #1. However, while the RFP #1 is centered on "the earliest state" of the universe (or "cosmic genesis"), this one focuses on "the current status" of the universe.

Big Question III

What is the origin of the complexity in the universe?

Exemplary sub-questions:

- (1) *What are the conditions for the universe to evolve to a high degree of complexity?*
- (2) *What are the key stages of increasing complexity in the universe? How do they come about?*
- (3) *Will the complexity of the universe continue to increase? If so, how long? Are there any theoretical limits to the complexity of the universe?*

We are living in a wonderfully complex world. According to the known astronomical and cosmological theories, our universe has become more and more “complex” and produced more and more interesting phenomena in it. How did this happen? What were the key stages? What are the prerequisites for such emergent complexity?

Through the process of becoming more and more complex, the universe generated conscious observers who contemplate the very meaning of existence of the universe as well as their own and ask the question: “Why are we here?” What are the origins of this amazing complexity in the universe? What are the origins and conditions of *continuing* complexity in the universe?

Will this trend continue forever? Or, are there any theoretical limits to the complexity of the universe?

Big Question IV

Are we alone in the universe? Or, are there other life and intelligence beyond the solar system?

Exemplary sub-questions:

- (1) What are the signatures of the existence of life and intelligence in the universe?*
- (2) Would the fine-tunings required for life in the universe also necessarily require that life be rare?*
- (3) To what degree are such other beings likely to be similar to humans? Are there features in nature which could limit the level of intelligence or the differences we may expect?*

The recent, rapid advances in technologies that allow the detection of exo-planets in the “life zone” and potential signatures of life and intelligence in the universe raise hope that we are getting very close to the stage to be able to answer the age old question: “Are we alone in the universe?” Discovering life and intelligent beings outside our solar system will be among the greatest scientific discoveries of all time.

While there are a number of other programs available with the focus of detecting the signatures of life in general, this program will focus more on detecting the potential existence of intelligence or advanced forms of life in the universe.

Some focal questions include, but not limited to: What are the potential signatures of the existence of intelligence (or advanced forms of life) in the universe? How may we detect them? Does our universe have features that limit the level of intelligence and/or the differences we may expect from them? What kinds of behaviour might we expect from them, if we ever meet them? Should we expect that they have learned how best to live with other beings as they must have survived their own conflicts long enough? What are the possibilities?